

Report on a line of Levels taken by order of the Right Honorable the Governor General, between the Jumna and Sutliij rivers. By Lieut. W. E. BAKER, Superintendent of Canals West of the Jumna.

The subject of inquiry proposed, having been to ascertain the practicability of establishing a water communication for the passage of boats between the Jumna and the Sutliij; I considered that the best preliminary measure would be to take a cross section, fixing at certain points the relative levels of those rivers and of the intermediate hill torrents, and the greatest height attained by the intervening ridges.

The line (viz., one between Kurnaul and Loodiana) which I selected for this section, was recommended by the following considerations:—

1st. It connects the highest points of both rivers to which boats of considerable burthen habitually resort.

2nd. It lies in a South-east and North-west direction, parallel to that of the Sub-Himalayas, and consequently perpendicular to the general lines of drainage.

3rd. It crosses each of the considerable mountain torrents before its junction with the Cuggur; and, lastly, its length was well suited to the time (about three weeks) to which, having no Assistant, I was obliged to limit my absence from the canals under my charge.

Having no accurate map of the country, I had merely a general idea of the direction from Kurnaul in which I should strike Loodiana, which will account for the deviations from a straight course observable in the accompanying map. My object being to note the general features of the country, I took no pains to avoid merely local inequalities, and my Section therefore exhibits much greater irregularities of surface than it need have done, had I had leisure previously to examine the ground ahead of my levelling instrument. The hollow in the neighbourhood of Puttiala, for instance, might have been in a great measure avoided by a more northerly course.

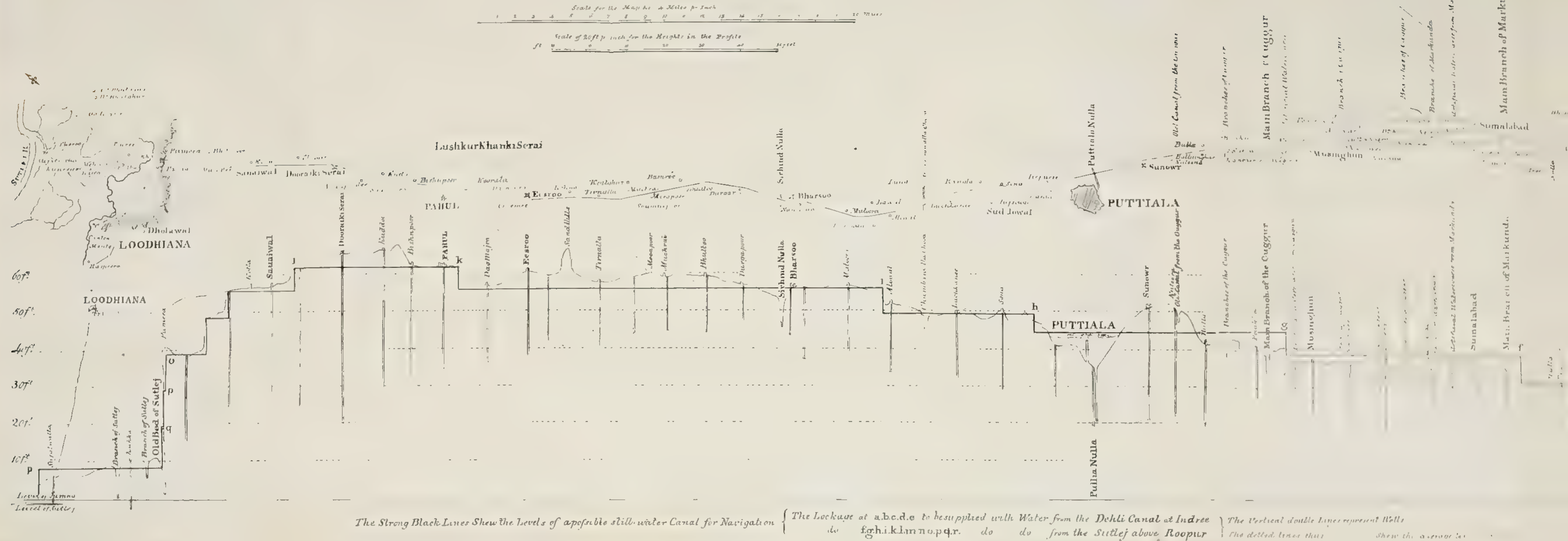
The information thus obtained is necessarily incomplete, and though it has in my opinion proved the practicability of the contemplated measure, it has not furnished data for a detailed project, and still less for an estimate of the probable

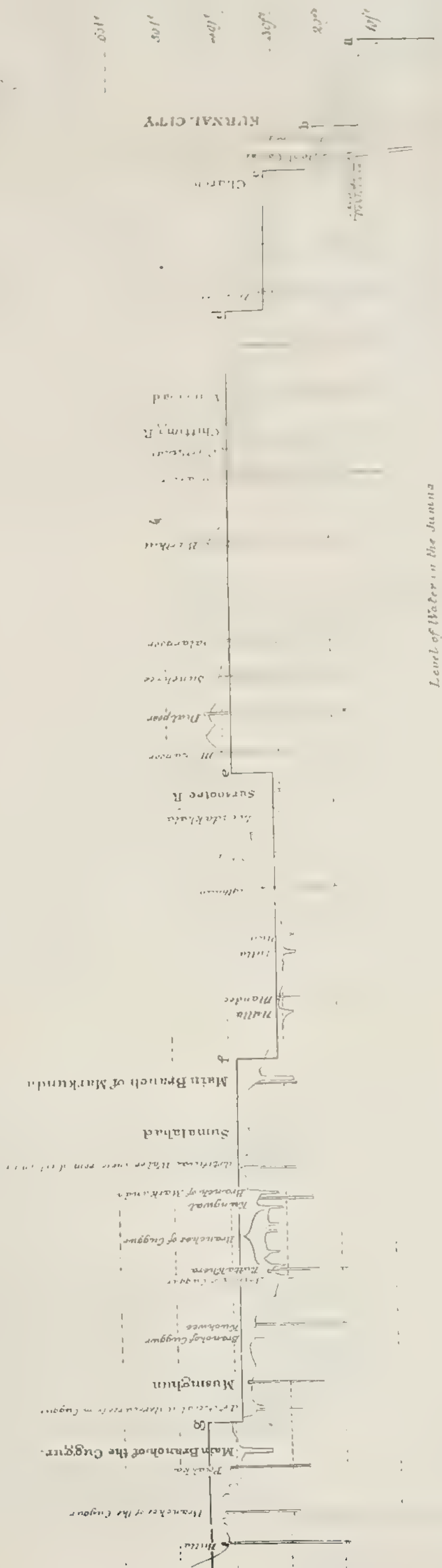
Irregularities and inequalities accounted for.

Nature of the information required.

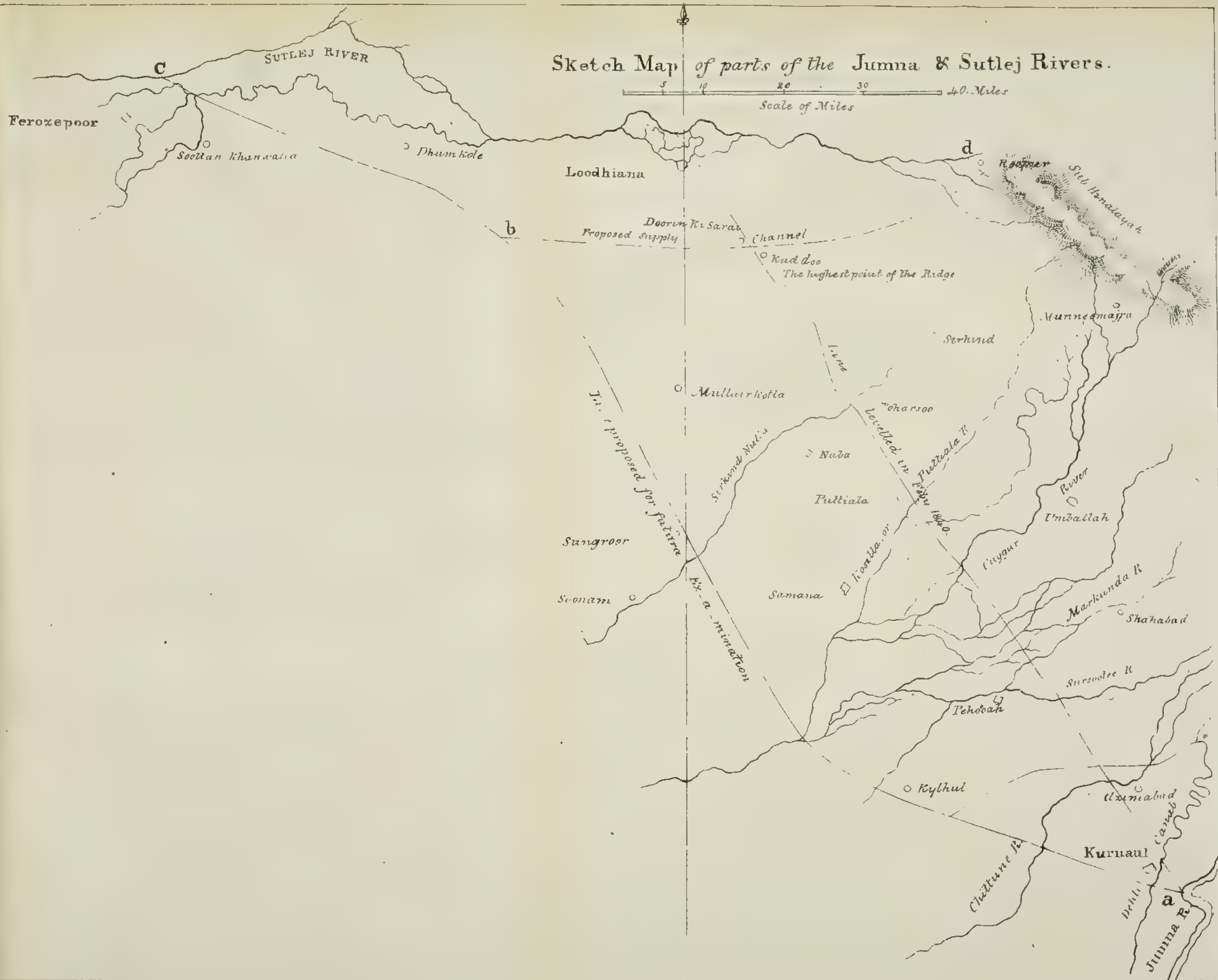
SKELETON MAP and PROFILE of a Line levelled between the JUMNA and SUTLEJ in February 1840.

to ascertain the possibility of connecting those Rivers by a Navigable Canal





tree } The vertical double lines represent Wells
hill } the dotted lines that show the



cost of the undertaking ; such as it is, however, I have judged expedient

Why now submitted. to communicate it at once, both as a report of progress, and to enable Government to decide whether or not it be advisable to prosecute the inquiry further.

The cost of the present survey amounts, as per contingent bill,
Cost of the survey. submitted to the Military Board, to Company's rupees 74 : 9 : 0.

In the accompanying Skeleton map and section, I have endeavoured
Reference to the Map to condense most of the information obtained, and
and Section. to show at one glance the result of my inquiry.

In this it will be seen, that from the level of the Jumna to the town of Pahul, near which the greatest elevation (67 feet, 11 inches, 25) is attained, there is a general rise, partially interrupted by the beds of intervening rivers, which may be thus particularized :—

The Chittung — an inconsiderable nullah, has no defined valley. Of

The Chittung river. its surplus waters, spreading out during the rainy season, right and left over the country, but little returns into its contracted channel ; and of late years, no considerable flood has reached even as far as Dhatrut, in the Jheend territory, from whence to Buhadera, in the Bikuneer State, the ancient bed of this river is occupied by the Canal of Feroze Shah.

From the ridge dividing the Chittung and the Sursootee, there is a considerable descent to the bed of the latter river, which may almost be said to have already joined the Markunda and the Cuggur at the point where I crossed them. From near Thanesur to

The Valley of the Sursootee, the Markunda, and the Cuggur rivers.

Konaheree, the whole tract of country (with the exception of village sites) is liable to inundation from the Sub-Himalayan torrents, diffused

Their peculiar character. over its surface by means of a net-work of natural and artificial water-courses, of which some are supplied from more than one of the rivers above named ; others, again, flow from one river into another, and during great floods (as I was given to understand) all three are frequently united. The inhabitants avail themselves largely of the inundation for rice cultivation, though

Their use for irrigation. during the present season at least, little advantage appeared to have been taken of the facilities afforded for irrigating Rubbee crops, which, where they existed, were

generally watered from Wells. I had not leisure to ascertain, by personal examination, whether the first diffusion of these rivers (which I have

Their diffusion ac- myself seen nearer the hills in single and separate
counted for. streams) were caused by natural or artificial means,

but it is probably attributable to both. The slope and evenness of the country, are calculated to favor even the rudest attempts to divert the streams from their original beds, and the same circumstances would also render it easy, were it desirable, to confine them again to one or two principal channels. What I have designated as the "main branches" of the Markunda and Cuggur, are distinguished from the others, not so much by their superior size, as by the presence of a small thread of running water.

The valley of the Sursootee, Markunda, and Cuggur, such as I have de-
scribed it, though extending to a width of twenty-
Their importance as an obstacle to the Canal. nine miles, would present no insurmountable ob-
stacle to the formation of a navigable Canal across it, though the ex-
pense attendant on the provision of the necessary embankments and
aqueducts, would be considerable. And on this account, as well as for
other reasons, to be noted hereafter, a more advantageous line for the
Canal would probably be found further to the south-west, below the
town of Sumana.

The river which flows past Puttiala, has a different character from
The Puttiala, or Kosil- the preceding. Its channel at the point where I
la river. crossed it, is so deep, that I could not have sup-
posed its waters would ever be capable of spreading out over the
country, had not the construction of an embankment between the stream
and the city (said to be for the protection of the walls), proved that it is
sometimes liable to overtop its banks. At this point, in consequence of
its deep narrow section, it would be easily crossed by a short aqueduct.

Immediately beyond the city of Puttiala, I encountered several ridges
of sand, which would most likely be avoidable on another line, but if
Sand ridges. not, it would merely be necessary to puddle the
Canal bed throughout their extent, to prevent heavy loss of water by
absorption.

The Sirhind Nulla, which I crossed about sixteen miles beyond
Puttiala, flows in one or more channels through
The Sirhind Nulla. a valley 500 or 600 yards in width, having but a

Its character and uses for slight depression below the adjoining country. Its irrigation. flood waters could, with very little labour and skill, be let out by side cuts to inundate the lands lying on its east bank, and I therefore conclude that such a practice is adopted, as the natives of this province are fully aware of the value of that peculiar system of irrigation, which consists in flooding the land once a year.

From the West bank of the Sirhind Nulla to a few miles beyond Sand ridges. Pahul, the land is generally level, but intersected by a few sand hills, one of which, between the villages of Bishnpoor and Kuddoo, may be considered the crest of the ridge, dividing the Jumna from the Sutliij.

From Doorai-ki-Serai westward, the descent is rapid, and the fall Descent to the Sutliij. appears to be broken in a remarkable manner into steps, ending in an abrupt cliff of 30 feet, on the western continuation of which stands the fort and town of Loodiana. At some former period this cliff was evidently the eastern boundary of the Sutliij, and even yet, as I am given to understand, the waters of that river when swelled by the monsoon floods, frequently reach its base.

The remaining tract of seven and a quarter miles, intersected by Valley of the Sutliij. branches of the Sutliij, is proved by its loose sandy soil, as well as by its topographical position, to be an alluvial deposit of the river; and were the canal to join the Sutliij at this point, it would be more advisable to deepen the Nulla which flows under the Fort, than to make a new excavation through such unfavorable soil.

As my commission did not include an examination of the Sutliij, I Capabilities for navigation near Loodiana. may perhaps not be expected to offer an opinion on its navigable capabilities; but I may be permitted to remark, *en passant*, that the stream near Loodiana appears to have two characteristics decidedly unfavorable to navigation; viz. a sandy Shifting sands. bed, and a considerable fall; a combination of circumstances which cannot fail to produce shifting and uncertain shoals.

With a view of ascertaining the level of springs along the line of my Depth of wells throughout the line. section, I measured the depth of 156 wells between Kurnaul and Loodiana, and the average result is shewn in the profile by blue dotted lines. In this I had two objects; first to ascertain whether, as some suppose, measurements of the level of springs would give data for an approximate calculation of the

profile of a country ; and, secondly, to obtain one element for calculating the amount of absorption in a standing canal, for which it would be necessary to provide a daily compensation. In the former respect my present observations, as well as those made with the same view in other localities, shew that the level of springs is too much affected by the vicinity of streams, the degree of permeability of soils, and other local circumstances, to admit of any accurate conclusion being drawn from them, regarding the profile of the surface. But with reference to the second object of my inquiry, it is satisfactory to find that the wells measured, have generally so little depth, as the waste by absorption in the contemplated canal, will be relatively much less. In illustration of this point I may mention, that in the Paneeput district, where before the introduction of the Delhi canal the springs were from thirty to forty feet below the surface, they are now from fifteen to thirty feet ; whereas in Hurriana the springs have been raised since Feroze's canal was opened, in some instances, as much as sixty feet.

On the accompanying profile I have sketched out what I consider to be a possible section of a still water canal, from the highest level of which, between Pahul and Doorai-ki-Serai, the westward descent of sixty-three feet to the level of the Sutliij, is made by means of seven locks ; while to the eastward a descent of thirty and a half feet to the valley of the Markunda and Sursootee, is effected in five locks, after which a partial rise of six and a half feet is necessary to cross the ridge separating these rivers from the Chittung, followed by a descent of thirty-eight feet, by four locks to the level of the Jumna. Water sufficient for the westward lockage, as well as to compensate for waste by absorption and evaporation, could be supplied at the highest level by a cut taken from the Sutliij, at the point where it debouches from the lower hills, and conducted along the crest of the ridge ; and on the eastern extremity of the canal, we might obtain water for the same purposes by a water-course from the Delhi canal above Indree. In sketching out this project, I would be clearly understood not to recommend it as an advisable one. The number of masonry aqueducts required here, the necessity for which

No sure index of superficial inequalities.

Effect on the amount of absorption.

Practicability of the measure illustrated by a possible Section.

Water for lockage and wastage, how obtained.

The possible Section not recommended as an advisable one.